INDOOR AIR QUALITY ASSESSMENT

Mixter Municipal Office Building
120 Prescott Street
West Boylston, Massachusetts

Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
Emergency Response/Indoor Air Quality Program
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Background/Introduction

At the request of the West Boylston Board of Health (WBBOH), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA) provided assistance and consultation regarding indoor air quality concerns at the Mixter Municipal Office Building (MMOB), 120 Prescott Street, West Boylston, MA. Concerns about symptoms (e.g. dry itching eyes, allergic rhinitis, dyspnea and respiratory irritation) believed to be attributed to poor indoor air quality and microbial growth due to chronic water damage prompted this inspection.

On July 8, 2003, a visit was made to the building by Cory Holmes, an Environmental Analyst in BEHA's Emergency Response/Indoor Air Quality (ER/IAQ) program, to conduct an indoor air quality assessment. Mr. Holmes was accompanied by Robert Barrell, Chairman of the WBBOH during the assessment. Also present for portions of the assessment were Kim Hopewell, Town Clerk and Barbara Mard, WBBOH Secretary.

The MMOB is a one-story, flat roofed, brick building originally built as a school in 1950. Town offices are located in former classrooms. The former cafeteria/auditorium is currently used as a public assembly room. Windows are openable throughout the building.

Methods

Air tests for carbon dioxide, temperature and relative humidity were taken with the TSI, Q-Trak, IAQ Monitor, Model 8551. Water content of gypsum wallboard (GW)

was measured with Delmhorst, BD-2000 Model, Moisture Detector with a Delmhorst Standard Probe.

Results

The building has a staff of approximately 20 with approximately 40-50 individuals visiting the building daily. The tests were taken under normal operating conditions. Test results appear in Table 1.

Discussion

Ventilation

It can be seen from the tables that carbon dioxide levels were below 800 parts per million of air (ppm) in all areas surveyed, indicating adequate ventilation in occupied areas of the building. However, it is important to note that all of the areas were sparsely populated and/or had opened windows during the assessment, which can greatly reduce carbon dioxide levels.

Fresh air is provided to office space by a unit ventilator (univent) system (Picture 1). A univent draws fresh air from a vent on the exterior of the building and air from the interior (called return air) through a vent in the base of the unit (Figure 1). Fresh air and return air are mixed, filtered, heated and expelled into the classroom through a fresh air diffuser located on the top of the unit. All outside air intakes for univents were sealed with sheet metal, eliminating the ability of the system to introduce fresh air (Picture 2). Univents on the east side of the building were removed and replaced with baseboard

radiant heat (Picture 3). A few of the remaining univents were operating during the assessment, however, with air intakes sealed, univents were only recirculating office air.

Exhaust ventilation is provided by grilled, ducted vents (Picture 4) connected to rooftop motors (Picture 5). A number of the exhaust vents were obstructed with file cabinets and other stored items (Picture 6). During the assessment, no draw from exhaust vents could be detected in any occupied areas. Lack of draw can indicate rooftop motors were deactivated or not operating. BEHA staff and Mr. Barrell examined conditions on the roof and found two of fourteen exhaust motors operating. Without mechanical supply and exhaust ventilation, indoor air pollutants can build up and lead to indoor air quality/comfort complaints.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of building occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment, however in their current state, these ventilation systems cannot be balanced.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (BOCA, 1993; SBBRS, 1997). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is

impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please refer to Appendix I.

Temperature readings were measured between 70^{o} F to 79^{o} F, which were close to the BEHA recommended range for comfort. The BEHA recommends that indoor air temperatures be maintained in a range of 70 ^{o} F to 78 ^{o} F in order to provide for the comfort of building occupants. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply. Temperature/poor ventilation complaints were reported to

BEHA staff in a number of areas. Temperature control is difficult without a properly functioning ventilation system (e.g. univents/exhaust vents deactivated).

The relative humidity measured in the building ranged from 32 to 59 percent, which was within the BEHA recommended comfort range in most areas. The BEHA recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Occupants have reported that the building has a history of roof leaks. The TV room had sheets of plastic polyethylene covering up electronics equipment to protect them from water damage. Water damaged ceiling tiles, walls and carpeting were noted in a number of areas (Pictures 7 & 8). Visible mold growth was observed on corkboard in the Coast Guard room and on the wall of the storage room off the main hallway (Pictures 9 & 10). Fungal growth was observed beneath/behind wooden framed corkboard in the main entrance, which is an area that has experienced chronic water damage (Picture 11). The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials (e.g. corkboard, carpeting, ceiling tiles) be dried with fans and heating within 24 hours of becoming wet (US EPA, 2001, ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged

porous building materials can provide a source of mold and mildew and should be replaced after a water leak is repaired.

BEHA staff examined the roof and found the rubber membrane to be rippled, brittle, and cracked in a number of areas. These rippled areas are breaches of the building envelope that can allow water penetration into the building. It was reported by town officials that attempts were made recently to repair some sections of the roof and no further leaks have been reported by occupants in the repaired section of the building.

Efflorescence (i.e. mineral deposits) was noted on walls in the main entrance and in the adjacent storeroom. Efflorescence is a characteristic sign of water damage to building materials such as brick or plaster, but it is not mold growth. As moisture penetrates and works its way through mortar around brick, water-soluble compounds in bricks and mortar dissolve, creating a solution. As the solution moves to the surface of the brick or mortar, water evaporates, leaving behind white, powdery mineral deposits. Several potential sources of water penetration exist:

- The exterior walls had spaces/cracks in brickwork. In many areas mortar around exterior brickwork appears to be crumbling or missing (Picture 12). These conditions are breaches of the building envelope and provide a means for water entry into the building. Repeated water penetration can result in the chronic wetting of building materials and the potential for microbial growth. Areas with missing or crumbling mortar have sustained heavy moss growth. In addition, large wall cracks may provide a means of egress for pests/rodents into the building.
- The roof of the building is reported to have problems with drainage. No gutter/downspout system or any rooftop drains were present in or around the roof at

the time of assessment. Instead, a portable electric pump attached to a garden hose is stationed on the roof to help remove water (Picture 13). Normally buildings are equipped with roof drains and/or a gutter/downspout system to collect and drain water away from the building. Lack of proper drainage can allow rainwater to pool on the roof and at the base of the building against exterior walls.

- Shrubbery/trees were in direct contact with the exterior wall brick in several areas around the building (Picture 14). Plants growing in close proximity to the building can serve as a possible source of water impingement to the exterior curtain wall. In addition, the growth of roots against the exterior walls can bring moisture in contact with wall brick and eventually lead to cracks and/or fissures in the foundation below ground level. Over time, this process can undermine the integrity of the building envelope and provide a means of water entry into the building through capillary action through foundation concrete and masonry (Lstiburek & Brennan, 2001).
- Broken windows were observed in the Town Administrator's office. Replacement of broken windows and/or repairs of window leaks are necessary to prevent water penetration. Repeated water damage can result in mold colonization of window frames, curtains and items stored on or around windowsills.

Other Concerns

Several other conditions that can affect indoor air quality were noted during the assessment. Exposed fiberglass pipe insulation was noted around end caps in a number of areas (e.g. senior center). Airborne fiberglass particles can serve as a skin and respiratory irritant to sensitive individuals. Occupants also expressed concerns about the

condition of asbestos pipe insulation and floor tiles. BEHA staff observed no friable insulation material around pipes. Floor tiles showed typical wear and tear and were cracked in some areas. Any damaged/friable asbestos containing materials should be remediated in conformance with all applicable Massachusetts' asbestos abatement and hazardous materials disposal laws.

Also of note was the amount of materials stored inside offices. In areas throughout the building, items were observed on windowsills, tabletops, counters, bookcases and desks. The large number of items stored provides a source for dust to accumulate. These items (e.g. papers, folders, boxes) make it difficult for custodial staff to clean. Dust can be irritating to eyes, nose and respiratory tract. Items should be relocated and/or be cleaned periodically to avoid excessive dust build up.

Office areas contained window-mounted air conditioners. Portable air-conditioning units are normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid build up and re-aerosolization of dirt, dust and particulate matter.

Open utility holes and wall spaces were noted in a number of areas (Pictures 15 & 16). These breaches can provide a pathway for the movement of drafts, odors and particulate matter between rooms and floors.

Unsealed plumbing pipes connected to a sink (Picture 17) were seen in the Town Clerk's office. Sink drains are usually designed with traps in order to prevent sewer odors/gases from penetrating into occupied spaces. When water enters a drain, the trap fills and forms a watertight seal. Without periodic input of water (e.g., every other day), traps can dry, preventing a watertight seal. Without traps, odors and other material can

travel up the drain and enter occupied spaces. Sewer gas can be irritating to the eyes, nose and throat of some individuals.

Occupants in the Town Clerk's Office reported infestation of hornets/wasps. Hornets/wasps were seen entering the space through an open utility pipe (Picture 18). Under current Massachusetts law that, effective November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in state buildings and grounds (Mass Act, 2000). Although not a state office building, the principals of IPM can be used in any facility.

Finally, mechanical exhaust ventilation in a number of restrooms was not functioning during the assessment. Other restrooms were not equipped with any local exhaust ventilation. Exhaust ventilation is necessary in restrooms to remove moisture and to prevent restroom odors from penetrating into adjacent areas.

Conclusions/Recommendations

The conditions noted at the MMOB raise a number of indoor air quality issues. If considered individually, the general building conditions, maintenance practices and the operation (or lack) of HVAC equipment present conditions that could degrade indoor air quality. When combined, these conditions can serve to further negatively affect indoor air quality. Some of these conditions can be remedied by actions taken by building occupants. Other remediation efforts will require alteration to the building structure and equipment. For these reasons a two-phase approach is required, consisting of **short-term** measures to improve air quality and **long-term** measures that will require planning and resources to adequately address the overall indoor air quality concerns.

The following **short-term measures** should be considered:

1. Remove and replace any mold contaminated/water damaged materials (e.g. carpeting/padding, cork board, gypsum wallboard). This measure will remove actively growing mold colonies that may be present. Remove mold contaminated materials in a manner consistent with recommendations found in "Mold Remediation in Schools and Commercial Buildings" published by the US Environmental Protection Agency (US EPA, 2001). Copies of this document can be downloaded from the US EPA website at:http://www.epa.gov/iaq/molds/mold_remediation.html
2. Supplement airflow in the building by using openable windows to control for comfort. Care should be taken to ensure windows are properly closed at night and weekends to avoid the freezing of pipes and potential flooding. Work with staff to determine which windows are unopenable/difficult to operate and make repairs.
3. Inspect rooftop exhaust motors and belts for proper function. Repair and replace as necessary.
4. Once rooftop motors are reactivated, remove all blockages from exhaust vents to ensure adequate airflow.
5. Ensure that abandoned exhaust and supply vents are properly sealed to eliminate pathways for movement of odors and particulates into occupied areas, if original mechanical ventilation systems are not restored to original function. This includes all former classroom vents as well as openings on the roof.
6. Reactivate exhaust ventilation in restrooms to remove odors and moisture.

7. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
8. Ensure roof leaks are repaired. Once repaired replace any water-stained ceiling tiles. Disinfect areas of water leaks with an appropriate antimicrobial.
9. Replace/repair broken windows to prevent water leaks and subsequent microbial growth.
10. Replace any missing ceiling tiles and fill utility holes, to prevent the migration of odors, dust and particulate matter between rooms.
11. Relocate or consider reducing the amount of materials stored in office space to allow for more thorough cleaning. Clean items regularly with a wet cloth or sponge to prevent excessive dust build-up.
12. Encapsulate exposed ends of fiberglass pipe insulation.
13. Remediated any damaged/friable asbestos containing materials in conformance with all applicable Massachusetts' asbestos abatement and hazardous materials disposal laws.
14. Change filters for window-mounted air conditioners and air-handling equipment as per the manufacturer's instructions or more frequently if needed. Vacuum interior of units prior to activation to prevent the aerosolization of dirt, dust and particulates.
15. Use of the principles of integrated pest management (IPM) to rid this building of pests is highly recommended. A copy of the IPM recommendations can be downloaded from the Internet at http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf.

16. For further building-wide evaluations and advice on maintaining public buildings, see the resource manual and other related indoor air quality documents located on the MDPH's website at http://www.state.ma.us/dph/beha/iaq/iaqhome.htm.

The following **long-term measures** should be considered:

1. Examine the feasibility of a total roof replacement. Hire a roofing contractor to evaluate existing roof membrane, ballast, substrate and all associated building materials. Examine the area above and around these areas for microbial growth. Disinfect areas of water leaks with an appropriate antimicrobial.
2. Examine the feasibility of enhancing drainage to areas of the roof subject to water pooling (e.g. east wing roof). Consider the installation of a gutter/downspout system or roof drains. This may include redirecting the pitch of the roof towards drains.
3. Examine the feasibility of restoring mechanical supply and exhaust ventilation. Based on the age, physical deterioration and availability of parts of the HVAC system, the BEHA strongly recommends that the HVAC engineering firm fully evaluate the ventilation system for proper operation, and/or repair/replacement considerations.
4. Evaluate thermostat settings throughout the building. Thermostats should be set at temperatures to maintain comfort for building occupants.

References

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BOCA. 1993. The BOCA National Mechanical Code/1993. 8th ed. Building Officials and Code Administrators International, Inc., Country Club Hill, IL. Section M-308.1.1.

Lstiburek, J. & Brennan, T. 2001. Read This Before You Design, Build or Renovate. Building Science Corporation, Westford, MA. U.S. Department of Housing and Urban Development, Region I, Boston, MA

Mass. Act. 2000. An Act Protecting Children and families from Harmful Pesticides. 2000 Mass Acts c. 85 sec. 6E.

OSHA. 1997. Limits for Air Contaminants. Occupational Safety and Health Administration. Code of Federal Regulations. 29 C.F.R. 1910.1000 Table Z-1-A.

SBBRS. 1997. Mechanical Ventilation. State Board of Building Regulations and Standards. Code of Massachusetts Regulations. 780 CMR 1209.0

US EPA. 2001. Mold Remediation in Schools and Commercial Buildings. US Environmental Protection Agency, Office of Air and Radiation, Indoor Environments Division, Washington, D.C. EPA 402-K-01-001. March 2001. http://www.epa.gov/iaq/molds/mold_remediation.html

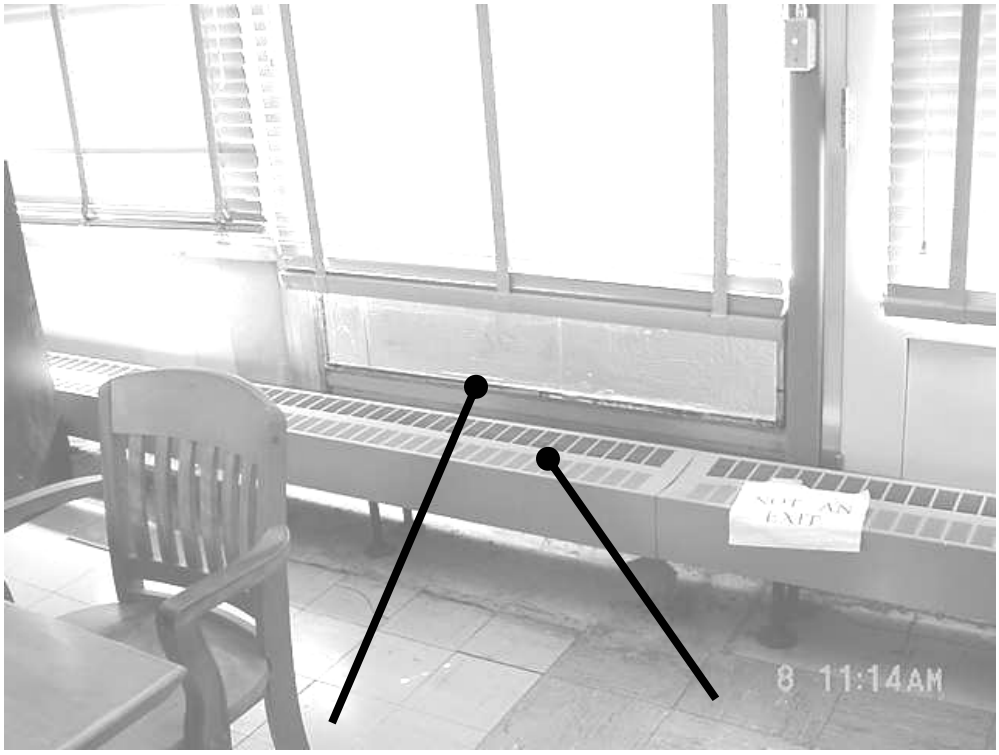
Picture 1

Typical 1950's Vintage Univent

Picture 2

Univent Air Intake Sealed With Sheet Metal on Exterior of Building

Picture 3



Univent Removed and Replaced With Baseboard Radiant Heat

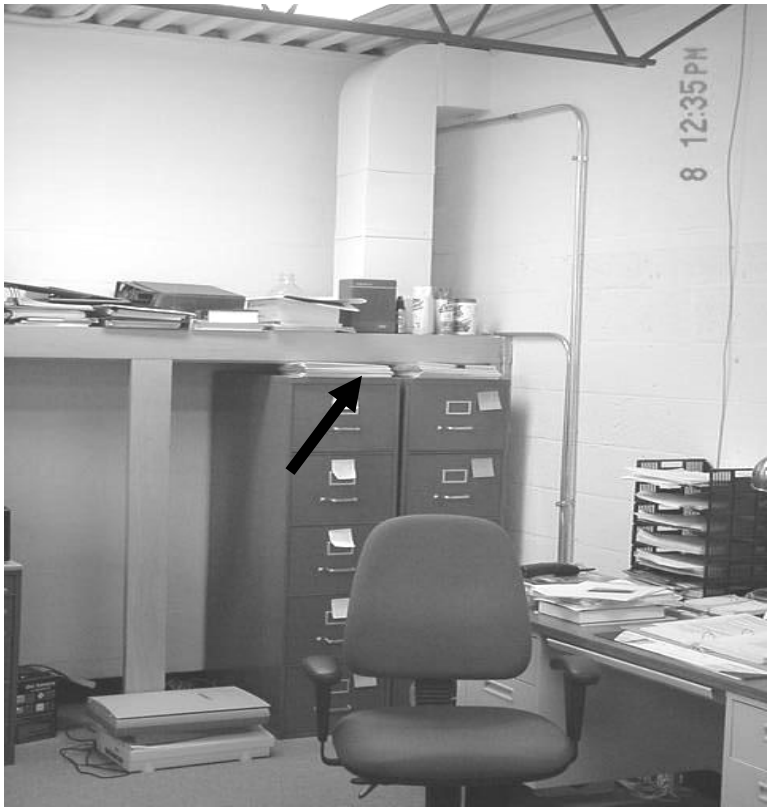
Picture 4

Mechanical Ducted Exhaust Vent

Picture 5

Inactive Rooftop Exhaust Vents

Picture 6



Exhaust Vent Obstructed by File Cabinets and Files

Picture 7

Water Damaged Carpeting

Picture 8

Water Damaged Ceiling Tiles

Picture 9

Water Damaged/Mold Growth on Cork Board in Coast Guard Room

Picture 10

Visible Mold Growth on Wall of Storage Room (Indicated by Dark Stains)

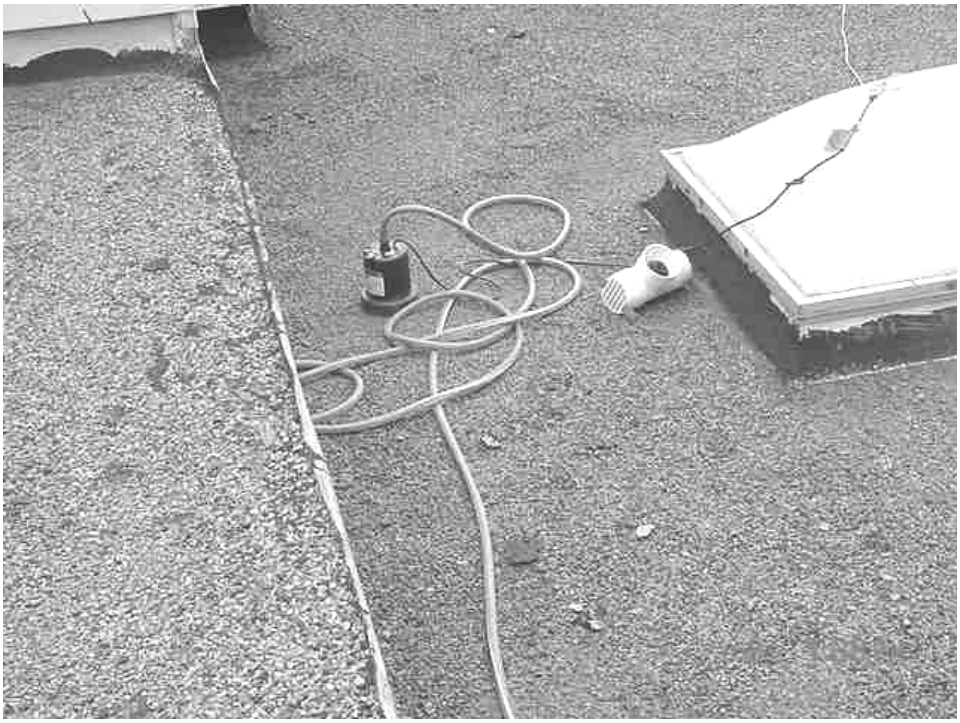
Picture 11

Efflorescence and Water Damaged Wooden Framed Cork Board in Main Hallway

Picture 12

Missing Damaged Mortar and Heavy Moss Growth between Bricks

Picture 13



Portable Pump on Roof to Remove Water

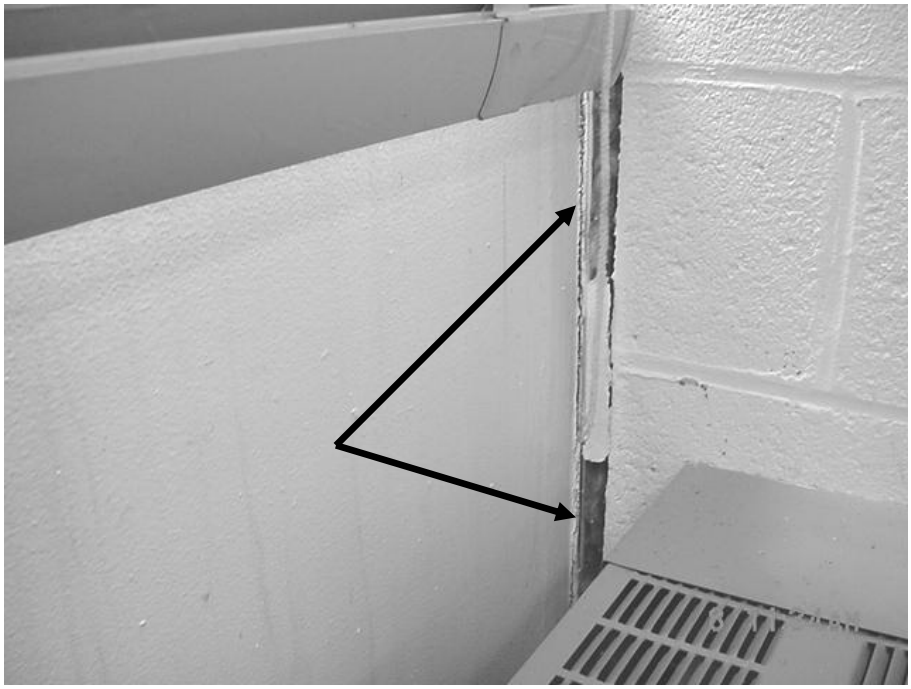
Picture 14

Trees/Shrubbery over Roof and in Direct Contact With the Building

Picture 15

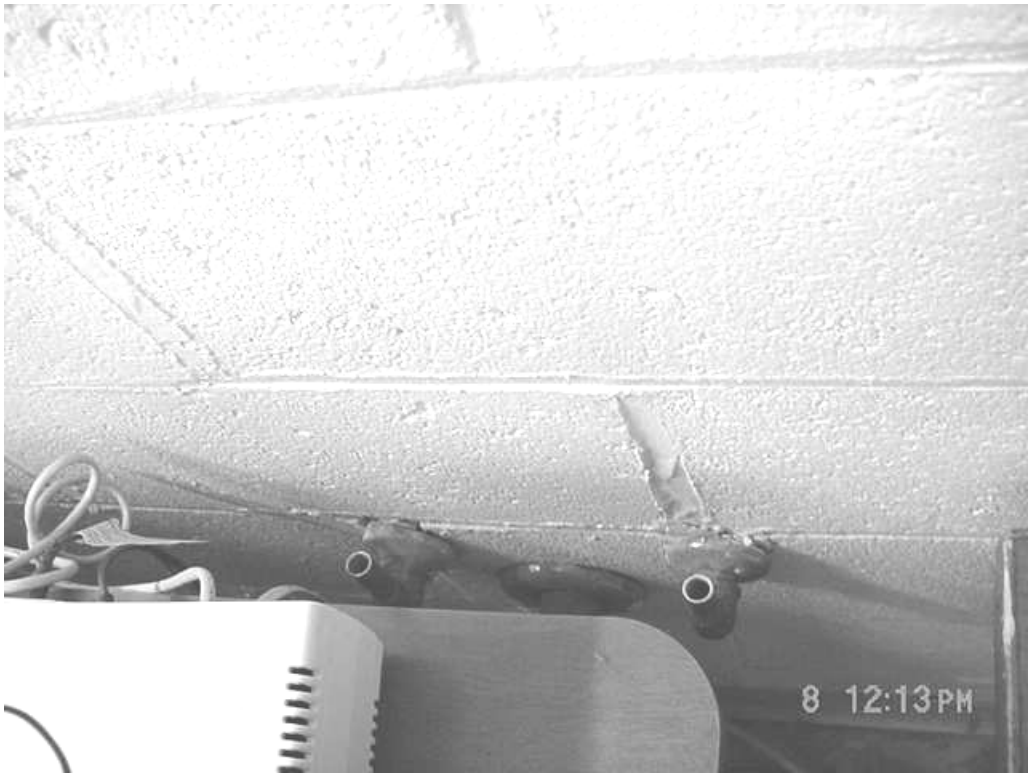
Open Utility Hole

Picture 16



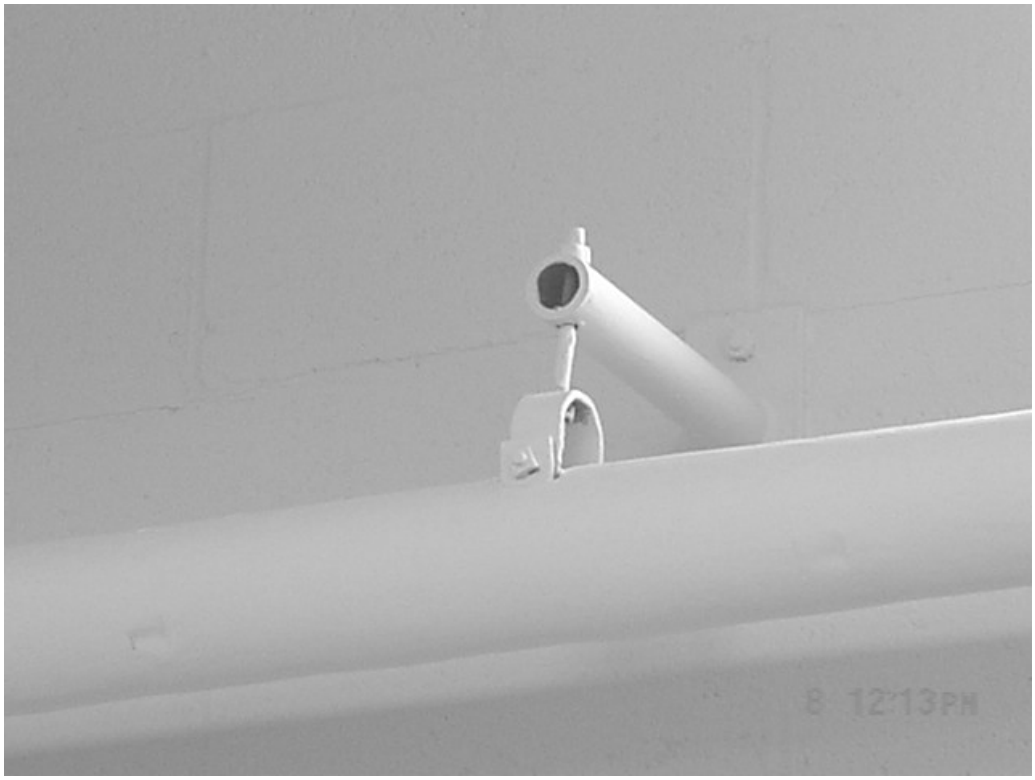
Open Seam in Wall Junction

Picture 17



Open Plumbing Pipes to Former Sink

Picture 18



Open Pipe in Town Clerk's Office Where Hornets/Wasps Were Seen

TABLE 1

Indoor Air Test Results –Mixter Municipal Office Building, West Boylston, Massachusetts July 8, 2003

Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Background	428	86	67					Hot and sunny Scattered clouds, light breeze
Board of Health Office	622	79	38	4	Y	N	Y	UV – removed, air intake sealed Baseboard heat, window AC Exhaust on – no draw Wall/utility holes/cracks
Coast Guard	549	89	59	0	Y	N	Y	Hot – no mechanical vent, WD/ mold growth, cork board, no supply exhaust not operating, WD stained carpet, storage of old office furniture, dust accumulation
West Boylston Senior Center	778	81	54	2	Y	N	Y	End cap – exposed fiberglass, exhaust off – obscured by items on shelf, curtain, falling caulking wall, dirty filter AC
Former Cafeteria/Auditorium	468	84	55	0	N	Y	Y	Used as auditorium, 3 Uvs – off – no filtration
TV Room	444	83	52	1	Y	Y	Y	Plastic hung from ceiling to protect electronics from roof leaks

*** ppm = parts per million parts of air**
UV = Univent
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide -	< 600 ppm = preferred
	600 - 800 ppm = acceptable
	> 800 ppm = indicative of ventilation problems
Temperature -	70 - 78 °F
Relative Humidity -	40 - 60%

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Location	Carbon Dioxide (*ppm)	Temp (°F)	Relative Humidity (%)	Occupants in Room	Windows Openable	Ventilation		Remarks
						Supply	Exhaust	
Assessor's Office	591	83	43	1	N	N	Y	Exhaust no draw Passive vent door/sealed
Assessor's Offices	626	81	46	2	Y	N	N	Spaces around AC Drafts, carpeted
Men's Rest Room	650	83	58	0	Y	Y	N	No exhaust – passive vent sealed Automatic air freshener
Women's Rest Room	648	84	53	0	Y	Y	Y	Exhaust no draw
Assessor's File Room	545	85	46	0	N	N	Y	Exhaust off Photocopier
Server Room	556	82	35	0	Y	N	N	Window AC
Town Clerk's Office	655	83	42	2	Y	Y	Y	Open pipe – hornet entry seen by occupants, sink removed uncapped pipes, passive door vent
Main Hallway	546	85	55	-	-	-	-	Chronic WD-efflorescence, wood framed corkboard-WD, leak repaired, inspect interior office heating vent
Sewer Dept.	649	86	45	2	Y	N	Y	Exhaust vent no draw, AC works

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						Supply	Exhaust	
								intermittently, plants, temperature/comfort issues
Boys Rest Room			49	0	N	Y	Y	Floor drain, passive door vent, dust accumulated on exhaust vents
Girls Rest Room			50	0	N	Y	Y	
Building Inspector	630	80	36	1	Y	Y	Y	WD carpeting , leak repaired Exhaust blocked with file cabinets
Tax Collector	602	79	37	1	Y	Y	Y	Utility holes UV air diffuser covered by boxes, historic leafs repaired
Town Accountant	547	80	36	2	Y	Y	Y	UV off – AC Exhaust off
Finance Room	511	82	53	0	Y	Y	Y	7 CT, vent off UV, local exhaust vent
Town Administrator Reception	623	81	32	1	Y	N	N	Exhaust vent sealed
Town Administrator	507	79	38	0	Y	N	Y	Exhaust no draw Carpet odors

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						Supply	Exhaust	
Town Clerk Storage	520	84	58	0	N	N	N	Fungal growth on wall, cinder block, no vent, leak repaired
Roof Notes								Rooftop membrane rippled, poor drainage-electric pump-hose, 2 of 14 exhaust motors off
Perimeter Notes								Damaged wall panels-breach of building envelope, missing/damaged mortar/brick east exterior wall, moss growth, trees/shrubs up against ext wall, 2 broken windows (town administrator)

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